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Time and Temporality as Mediators of Science Learning

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Time and Temporality as Mediators of Science Learning

Abstract

Few studies have focused on understanding how teaching and learning in classrooms are mediated by other dimensions of the organizational systems of which education is an integral part. Our seven-year ethnographic study of an urban high school shows how time and temporality constitute key practical and theoretical resources to the actors in the cultural organization of schools, a product of transactions involving individuals and artifacts that traverse multiple cultural fields, each with its own distinctive structures.

Biographical notes

Wolff-Michael Roth is Lansdowne Professor of Applied Cognitive Science at the University of Victoria. His interests are broad, including long-term (5+ years) ethnographic studies in schools, fish hatcheries, and scientific laboratories focusing on knowing and learning across the life span from cultural-historical perspectives. Some of his recent works include *Doing Qualitative Research* (SensePublishers, 2005), *Doing Teacher Research* (SensePublishers, 2007), *Learning Science: A Singular Plural Perspective* (SensePublishers, 2006) and *Talking Science: Language and Learning in Science* (Rowman & Littlefield, 2005).

Kenneth Tobin is Presidential Professor of Urban Education at the Graduate Center of City University of New York. His research interests are focused on the teaching and learning of science in urban schools, which involve mainly African American students living in conditions of poverty, and coteaching as a way of learning to teach in urban high schools. Recently he edited a handbook about *Teaching and Learning Science* (Praeger), co-edited *Doing Educational Research* (SENSE), and co-edited *Improving Urban Science Education* (Roman and Littlefield).

Stephen Ritchie is an Associate Professor in Science Education at Queensland University of Technology, Australia. His recent research projects are concerned with curriculum leadership, research collaboration, student learning from writing about scientific phenomena within fictional storylines, and transitional experiences for beginning science teachers. Recently he co-edited *Metaphor and analogy in science education* (Springer, 2006) and edited *Research collaboration: Relationships and praxis* (SensePublishers, 2007).

In education, questions of teaching and learning usually are addressed at the individual or classroom level, which is based on an assumption that these units can be uncoupled from the larger social, cultural and historical contexts without affecting the outcomes of the analyses. In this article, we adopt a different approach. The school district, school, and departments or academies within a school, all organizationally complex, are regarded as cultural fields—"a field may be defined as a network, or a configuration, of objective relations between positions" (Bourdieu & Wacquant, 1992, p. 97)—within which other cultural fields are nested. For example, in the particular school at the center of our ethnographic study (known as City High School or CHS), the constituent fields include the administrative offices (principal, assistant principal, roster chairperson, operations officer), classrooms and computer labs, coordinators' offices, staff rooms, hallways and staircases, and the entrance doorway to the school (with metal detector). Each cultural field is characterized by material, social, and schematic structures that are appropriated by—and therefore enable and constrain—participants as they enact culture. Here we understand *culture* to denote the ensemble of standard practices, artifacts and tools, and agential possibilities that define a particular society or community. Each cultural field has its own logic (e.g., Brooker, 2002) and the coherence of practices across fields normally is weak. The different fields within the school support different forms of cultural enactment and reflect and map out social differences, belief patterns, interpretive frames, and power relationships; and each field has its own temporal dynamics that arises from "its structure, and, in particular, in the distance, the gaps, the asymmetries between the various specific forces that confront one another" (p. 101). Because of the differences and weak coherence between fields, there is great potential for contradictions and conflict to arise when different fields interact. In the present study, these contradictions and conflicts were associated with the different temporal dynamics in interacting fields.

Our seven-year ethnographic effort was devoted to understanding the difficulties students, teachers, and administrators face in bringing about high-quality teaching and learning of science. The purpose of this article is to report a major finding: how the different temporal structures in interacting cultural fields are the sources of contradictions and conflicts that pervade CHS in

ways that extend beyond studies that have explored the use of time in classrooms. For example, although there are numerous doorways to CHS, only one is available as an entry point for more than two thousand students; this doorway and the requirement that everyone enter through it structures time not only in this field but mediates the unfolding of time in other fields as well. We repeatedly found two- to three-hour disruptions of science instruction (fields 2, 3, etc.), because it took that amount of time to get all 2,000 students through the gun checks at this one gate (field 1). Because of such disruptions, students who do not make it to class because, having been 5 minutes late, they are turned away at the gate, thereby affecting school subjects such as science where continuity is required because concepts build on other concepts, and (laboratory) skills build on other skills. If students are absent (for part of lessons, for entire lessons, for part of the week) and if there are continual disruptions, then students are unlikely to be exposed to the conceptual practices required in the teaching of a cumulative science curriculum. In this field, the metal detector, school police officers, and other non-teaching staff are structures that mediate what students can and cannot do to enter school.

Some readers might be tempted to think that it is not so much of a finding that temporal misalignments in interacting fields of action lead to dysfunctional organizations. Yet why would such misalignments continue to exist if they could be recognized so easily, and why do people not simply realign the fields to support rather than interfere with teaching and learning? In this study, we tackle the problem of time because organizational researchers have consistently overlooked the qualitative analysis of organizational time (e.g., Orlikowski & Yates, 2002) even though most practitioners regard the resolution of contradictions associated with organizational time as essential and a matter of common sense. In organizational studies, time has been recognized only recently as a new research lens in organizational studies (Ancona, Goodman, Lawrence, & Tushman 2001) and considerable effort is now spent to understand better time as a resource in and for organizations and on practical issues implementing these findings (e.g., Antonacopoulou & Tsoukas, 2002). It seems important to us for research to go beyond what practitioners know from their everyday, unquestioned understandings because these include *relations of ruling* (Smith, 2005)—e.g., in the concepts used, in the transactional practices

deployed—that subject some individuals at the expense of those who are to gain. Dorothy Smith designed and theorized *institutional ethnography* as a means of beginning to understand relations of ruling in peoples' (practitioners') lives and to use the understandings gained to transform the lives from within: institutional ethnography is a sociology from people for people. As is often the case with everyday understandings, during praxis much of what is enacted happens without conscious awareness and it is only when events are brought to their attention that insiders assert, "this is not new, just common sense that everybody knows." Of course everybody knows once it is pointed out, and it is for this reason that institutional ethnography specifically and ethnography more generally often yields assertions that do not surprise insiders. Rendering the familiar strange for the purpose of better understanding some aspect of culture is at the very heart of ethnographic research. We regard this as one of the most important reasons to do institutional ethnography in urban schools, to document what happens and explore the ramifications of the patterns we identify as salient. It is in this spirit that time is the focus of our attention in this article.

Background

In the 1980s many studies examined science achievement in particular in relation to time-related variables such as time on task, pupil engagement, and wait time (Tobin, 1987). Simultaneously policy makers were concerned with the time allocated to particular subjects and the ways in which the time for science studies was distributed through the week (i.e., double periods for labs, block scheduling etc). Especially in the recent education research literature, however, time has been studied seldom and policy is shaped by the common sense knowledge of policy makers, hence making it difficult to argue from a foundation of empirical support for temporal issues being salient to policy making.

In relation to teaching and learning at CHS, time is salient in the organizational structure of the school. To realize the stated purpose of our research, we describe in this article what is accepted by some as common knowledge and address the implications of failing to contest—in the manner of a critical and self-critical institutional ethnography—status quo commonplaces

regarding time. For example, the number of science concepts typically taught in a lesson depends on its length. An administrative change that lengthens lessons from 55 to 96 minutes mediates not only learning (can students maintain focus for almost twice the length of time?) but also the nature of teaching—teachers who have taught single periods for much of their 10 or 20+ years of teaching may have to adapt well-functioning routines (planning and teaching two or three concepts per lesson) to take advantage of the different time allocation. Such transitions may be difficult, meet with resistance from a variety of stakeholders, and therefore lead to conflicts on the inside of organizations despite a commonsense nature that someone else might ascribe to the problems.

In this study, we focus on time and temporality, because these were such *central* resources to our participants and yet is so little described and theorized in the scientific literature on organizational behavior.[1] Thus, our participants constantly *manipulated* time when they, individually and collectively, *took* time (to come to class), *made* time (for meetings), *determined* the right time (for setting exams), *changed* pace (by alternating science activities), *adjusted* rhythms, *sequenced* teaching strategies, *integrated* multiple activities and relationships simultaneously, and *modified* other dimensions of duration and change. This active use and production of time and temporality often is not or is not sufficiently appreciated, though it is a central aspect of any competent practice (e.g., Giddens, 1991). Here we take *time* to be the dimension in which practice irreversibly unfolds and that practice irreversibly constitutes; *temporality* refers to the structure of time, including its rhythm, tempo, and its directionality: "Because it is entirely immersed in the current of time, practice is inseparable from temporality, not only because it is played out in time, but also because it plays strategically with time and especially with tempo" (Bourdieu, 1990, p. 81). That is, we are not just subject to time that somehow impinges from the outside—as this may appear from statements such as "I don't have time" or "Time is running away"—but through our agency (i.e., power to act) we actively

[1] Despite some important earlier anthropological and sociological work on the cultural dimensions of time (e.g., Adams, 1990; Hall, 1983; Zerubavel, 1981), in the science of organizations and organizational behavior, the focus on time is a recent advance less than three or four years old (e.g., Antonacopoulou & Tsoukas, 2002).

produce temporal metrics to suit the occasion, thereby changing the structures of the different fields in which we act (Merleau-Ponty, 1962). We (the authors) certainly are aware of the fact that there are many aspects of social life where temporal and spatial dimensions are linked—the amount of time that needs to be made between consecutive courses depends on the distance it takes normally walking students to get from one classroom to the next without being late—in this article, we focus on time and the temporal dimensions of practice to bring these dimensions into science education discourse.

As in earlier research we begin this investigation with a minimal theoretical framework. This framework is built around the mutually constitutive association of the cultural *practices* of participants, on the one hand, and the *structures* available in the cultural field, on the other (Sewell, 1999). These structures exist in two mutually constitutive forms: the cultural-historical *schema* concretely realized in perceptions and actions by each person and the material *resources* in their surroundings. *Fields* are the places in which culture is enacted; they are weakly bounded such that they give rise not only to dominant cultural practices but also to practices typical of other fields. We adopt a dynamic view of structure, which we understand as being in continuous flux because every time participants act, the results of their actions become *new* or altered resources in a field such as a classroom. At the same time, actions may produce resources sufficiently similar to previously existing ones so that it is possible to speak about the *re*production of structures. In realizing the purpose of this study, we examine how the collective and individual agency of participants, is afforded, not only by the presence and absence of equipment and supplies, but also by the practices and schema of others, enacted in a context of priorities, goals, and roles and the extent to which responsibility for them is collectively negotiated and enacted. Given the fundamental ways in which time is involved in all human activities, its absence in theorizing and researching human activities including knowing and learning is a significant limitation (Lemke, 2000).

Our research contributes to the science education literature by exploring time as a structure that mediates the teaching and learning in a large inner city school; time is such an important feature and concept, because those most concerned and affected—principals, coordinators,

teachers, and students—can and in our case did squarely address problems through better temporal coordination of their social relations. However, in the absence of research and coordinated effort, the agency of individuals only seemed to exacerbate the contradictions, leading to morale problems and creating contexts in which participants were inclined to accept a lack of resources as normal; the way things are in urban schools.

Research Design

This study is part of ongoing ethnography of teaching and learning in urban schools. In the course of a seven year period of close collaboration with teachers, administrators, and students (which included joint publications with numerous coparticipants such as teachers and students), we have established an extensive database containing ethnographic observations captured in field notes, videotaped lessons, written productions of participating teachers, and tape-recorded interviews with various stakeholders. Our research was designed to understand how different levels of the school, as an organization, mediate teaching and learning at the classroom level.

School Context and Participants

This study was situated at CHS, an urban school in a large city of the Northeastern US. More than 2,000 students attend CHS. Of these, 98 percent are of African American descent and more than 90 percent live below the poverty line or are from working class families. For various reasons, often related to poverty, the average daily attendance rate is 72 percent. The school is organized into academies, each including about 300 to 400 students and organized around a different core idea that organizes the curriculum (e.g., “health,” “business,” or “science, engineering, and mathematics”). In this study, we focus on events in an academy with a science, engineering, and mathematics theme (SEM), which historically prepared more students than any other academy for college entry. Our past research in schools like CHS suggests that the curriculum often is enacted at a minimal level: some students do not or rarely engage in activities; and there is often a shortage of equipment, supplies, and textbooks. Teachers and students identify as salient issues such as a lack of motivation to learn and teach (e.g., Ritchie,

Tobin, & Roth, 2007). Although we have observed contrary cases, teachers place the blame for this state of affairs with the students and the situations in which they live; they comment on the lack of commitment at the district level and at funding levels that are far below those of suburban schools. Students often blame their teachers—whom they experience as teaching in boring ways, being ill prepared, and treating them in demeaning ways—and with administrators—whom they experience as scheduling them into inappropriate classes that have little relevance to their interests or future studies and employment.

In this article, we feature only some of the participants in the research with their names, while others are cited by their function (e.g., assistant principal, operations officer, chemistry teacher, etc.). The principal adult participants for this article are Cole, the roster chairperson, Ruben, the coordinator of SEM, and Bryant, one of the engineering teachers in SEM.

The researchers also have been integral part of the school context. Roth has been conducting research at CHS in collaboration with the second author for several years. During his repeated one-week intensive visits to CHS (2 to 4 visits per year over the 7 years), he videotaped interactions between students, between teachers, and between teachers and students in classrooms, offices, and halls. The first author also conducted interviews with students, teachers and administrators. Tobin has a longstanding association with teachers, administrators, students and even parents in his capacity as researcher and coteacher at CHS. During this phase of the study, he observed classes and conducted interviews with students and teachers. Ritchie observed classes for two to three days each week for a period of five weeks at the school. He also conducted interviews with teachers, students and administrators as well as video-recording several cogenerative dialogues. All researchers constructed field notes and narratives of interactions between participants. These were shared and discussed face-to-face as well as by email after the intensive observation period.

Organizational Changes during the Seven Year Ethnographic Effort

The ethnographic research in science education commenced in the winter semester of 1998 when Tobin began to coteach with Spiegel, the science teacher in a small learning community (school within a school) called *The Opportunity Center* designated for students who were not succeeding in school and oftentimes who were returning from prolonged absences for such reasons as child birth and suspension. Nicknamed *Opportunity,* the center was one of 10 small learning communities where students suspended from other public schools found themselves after being admitted to CHS. Our ethnographic effort focused on teaching and learning science in urban schools generally but in *Opportunity* more specifically. The study was collaborative with teachers and students assuming roles as researchers, teacher educators, and curriculum designers. A significant emphasis was auto/ethnography as *coteaching* and *cogenerative dialogues* were developed as methods for learning to teach and became research methods (Roth & Tobin, 2002). Coteaching involved two or more individuals taking full (shared) responsibility in panning and enacting the curriculum, which provided opportunities for new teachers to be inducted, resident teachers to engage in in-service professional development, university supervisors to participate in evaluation, researchers to conduct research and so forth. To make sense of the lessons, to evaluate teaching (and learning), all teachers and student representatives regularly met after the lesson (during lunch breaks, after school) to participate in making sense collectively.

In the Fall of 1999 the principal of CHS was hired as superintendent of a large urban school district and the assistant principal was appointed as principal. An African American female, the new principal was a dynamo in the sense that she had an energetic presence in the hallways and classrooms. Her voice could be heard throughout the school and through her presence and actions she demonstrated that she expected a lot from faculty and students, and cared about the quality of education at CHS. Because of the departure of the principal some of the key administrative faculty left to assume positions in the other urban school district. Ms. Branchi was invited to assume a position as coordinator of a SLC referred to as *Sports, Entrepreneurship and*

Technology (*SET*). Knowing of the innovative teaching of Spiegel and his research on teaching and learning and learning to teach, Ms. Branchi invited him to teach in SET. Accordingly, the research moved from *Opportunity* to *SET*. In the Fall of 2000, Spiegel left to teach in an adjacent state in a school where he could earn significantly more money. His replacement was a Cuban African American, here referred to as Ruben. For a variety of reasons, including the strong emphasis on research in science education and learning to teach science, Ms. Branchi and the principal decided to rename the SLC as *Science, Education, Entrepreneurship and Technology* (*SE^2T*). The students were not involved in the name change and those who had not graduated along with those just entering as freshmen were associated with a SLC with a focus that differed significantly from what they might have thought when they first enrolled.

Ruben was a well-qualified and enthusiastic chemistry teacher, and he was regarded by the principal as a prized hire and a likely leader of the science teachers within the school. Ruben and Branchi collaborated closely on research and administration and did such an outstanding job that, when the principal decided to restructure the school from 10 SLCs to 6 Academies, she invited Branchi to be coordinator of the science focused Academy, which they labeled as *Science, Engineering and Mathematics* (*SEM*). The students from two SLCs, which had expressed interest in pursuing further studies at College, were placed in *SEM* and Ruben joined several other science teachers in the Academy. At this time Ruben accepted an invitation of the principal to assume a role of coordinator of science—a position that got him involved in coordinating the uses of resources across the 6 Academies. After one year in this position the administrative structure of the school was to change radically.

Because of a long history of failure the school district of Philadelphia was taken over by the State and the relatively new Superintendent decided to shake up the administration of high schools. In the fall of 2003, the principal of CHS was promoted to a position in central office and an assistant principal, also an African American female, became principal. Ms. Branchi was appointed as assistant principal, and Ruben was selected as coordinator of *SEM*. The research involving CHS continues to the present time with Ruben completing a dissertation in which he

focuses on his teaching of science in SE^2T and SEM and Branchi also writing a dissertation in which she explores connections between administrative practices and the ways in which science was taught and learned at CHS. To this day, we remain in close contact with student researchers who commenced their research with us as freshmen. Although Ms. Branchi made the initial selections of student researchers based on those who were most at risk of dropping out of school, many have finally graduated from high school and have forged their way into higher education. One of the student researchers is now a mother and in just a few instances we have lost contact with the youth.

Data Sources

Our research draws on *institutional ethnography* (Smith, 1987), a research method appropriate to studying phenomena that occur in school contexts at multiple timescales from the position and through the lens of stakeholders. Institutional ethnography includes discourse analysis and micro-analytic studies of social interaction, employed for the purpose of uncovering the actualities that the people in a situation can describe and accomplish in the processes of an organization. As part of establishing data sources, we construct observational, methodological, and theoretical field notes; we videotape lessons, sessions in which different stakeholders make sense together ("cogenerative dialogue" is the term used by administrators, teachers, and students within CHS to denote these sessions), and spontaneously occurring meetings; we interview students, teachers and administrators individually or as groups; and we include audio-taped interviews that high school student research assistants conduct with their peers. Some teachers are equipped with recorders to ensure that their talk is captured at all times and recorders are placed on various student desks to assure that many contributions to whole-class conversations are recorded clearly and are available for analysis. Recorded events are transcribed in an ongoing manner and are enhanced by salient video frames. The audiotapes of classroom events, interview sessions, and cogenerative dialogues are transcribed and made available for collective analysis by the research team. In this study, we draw on all the data sources that we have assembled in the

course of our seven-year study. For the present purposes, we selected episodes that saliently depicted the phenomena under investigation—time and temporality—but there are many other episodes that could have taken their place. The choices have been made on pragmatic grounds, often driven by the fact that the episodes be describable within the limited space this journal has available.

Data Interpretation

Consistent with our theoretical framework, data interpretation in our research integrates different levels of social analysis. Sociologists distinguish macro-, meso-, and micro-level for orienting their analyses to the different scales of social phenomena (Smith, 1990), levels that we treat heuristically and as standing in a dialectical relationship, which means that the three levels mutually presuppose each other. The three levels are associated with phenomena at the scale of social structure (macro), organizations and institutions (meso), and concrete action and interaction (micro): Macro-level structures are produced through concrete actions at the meso- and micro-levels, which in our research are revealed by interpretations of ethnographic and frame-by-frame video analyses, respectively.

Our interpretive work begins during fieldwork, where we share first impressions and understandings during the downtime between meetings and observations. For example, although we knew from prior experience that the contingencies of a school day interrupt interviews and research meetings, the central role of time as an organizational phenomenon was not salient. Time therefore became an organizing theme in our fieldwork. We began to write comments such as “Stress arising from not knowing, misalignments between individual and organization” or “Institutional time scales, individual time scales. The school needed to order this early, before they could know who would be teaching what . . .” (October 20, 2003); and we elaborated fieldnotes concerning temporal issues. The following paragraph was written as a field note one of us had recorded:

Assertion: The roster system and the timescales are interrelated.

> Well, I thought we would solve it with this situation. They started out with the charters, small learning communities, now they are called academies. And we still haven't been able ((interruption, note being brought in)) we still haven't solved it. And I think one of the reasons we haven't solved it, we do not start planning early enough. For instance, we need to know what our teacher allocation will be; and the number of students in your school determines the allocation. So sometimes by February, things should be stable, we can start planning. But they give us our allocation based on May numbers, and May numbers could be down. A lot of, from what Mr. Cole has told me, a lot of times principals want to wait to plan. (Assistant principal)

In this situation, making the roster is determined by the temporality of the school district, which makes its allocation for the coming school year based on its May projections for the number of students. From the school's (assistant principal's) perspective, it ought to be possible to start the roster process in February, at which point the projections for the number of students during the subsequent school year stabilize. Furthermore, the roster process at this school is a substantial task, so that the process should begin as early as possible. Here, two different timescales intersect and interact, leading to what is considered to be a late start at the school. At the same time, the school cannot plan the hiring of teachers, for the number of staff on its roster will also depend on the number of students and the associated allocation it receives from the school district. (October 30, 2003)

The field note begins with an assertion, followed by an interview excerpt and a first interpretation. Such assertions and the field note content subsequently became the focus of intensive, off-site discussions soon after the events occurred. In subsequent meetings, which included some or all of the researchers, we took particular events and analyzed them in increasingly greater detail. Our videotapes, which we tended to replay as often as we needed, became central resources in the meaning-making processes at the micro-level; this allowed us to ensure that our theorizing remained grounded in the institutional ethnography (Smith, 2005). These research meetings are recorded, transcribed, and made available for analysis.

To deepen the interpretations, we go through the data sources individually and collectively, generating and naming patterns and associated contradictions, and articulating additional hypotheses. We then engage in repeated cycles of reading to test the extent to which patterns and contradictions recur, and hypotheses are confirmed or disconfirmed in the remainder of the data sources. Our discussions ultimately lead to statements that are consistent within the data sources we collected. For example, the following excerpt from an email constituted the first full articulation of the role of time in relation to the organizational structure.

> A school is a field and so too are the constituent parts. Fields are located in physical and temporal spaces and intersect with one another. At the intersections there can be contradictions because structures (including, but not restricted to time) from all intersecting fields can constrain social life; the availability of these structures affords agency and the production of new culture as well as contradictions that need to be resolved (in all fields in which they appear). Time in its various social manifestations is part of the structure and hence the agency|structure dialectic in each field. (Field note, November 17, 2003)

The three researchers agreed that this statement accurately reflected what we had learned from our collaborative ethnographic study so that we adopted it as a lens for writing this article.

Quality of Interpretations

To improve the quality of our research, we adhere to the criterion of credibility, the qualitative researchers' equivalent to internal validity (Guba & Lincoln, 1989). Credibility includes the six dimensions: (a) prolonged engagement, (b) persistent observation, (c) peer debriefing, (d) negative case analysis, (e) progressive subjectivity, and (f) member checks. In our studies, we enact these dimensions in the following ways. First, we have conducted research at the school over a period of nearly seven years, allowing us to build rapport and gain the trust of many stakeholders at the school, including students, teachers, coordinators, non-teaching assistants, the assistant principal and the principal. This allowed us to take our assertions back to

the school participants. For example, the following excerpt was recorded as part of an interview with Bryant, and allowed us to deepen our understanding of time as a resource (opportunity, constraint) and product in the multi-level coordination of school as an organization.

Bryant: And then I had jury duty in the week.
Interviewer: Oh really, did you have to go?
Bryant: That was the thing. [Ruben] told me to try to get out of it but my new teacher coach said you've got to do it, so go for it. You are supposed to be able to get a substitute if you know ahead of time and that caused me some stress trying to get out of it and trying to prepare in case I couldn't get out of it plus the confusing messages trying to do it in the microseconds between periods. And there was also a funeral I couldn't go to because it was in the middle of the week and it was right next to the jury duty and I really wish I could have been there for that. So that was really disappointing.

Second, over this seven-year period, we have consistently collected data and thereby established a large database, including the data sources described above. Third, we interact each Thursday with teacher researchers from other schools: they pursue different research questions and, with respect to our research, they are disinterested peers. Fourth, consistent with our theoretical commitments, we expect negative cases (contradictions) to be ever present and actually seek them out because they constitute points of departure for our change-related efforts. Fifth, to achieve progressive subjectivity—i.e., an awareness of the historical development and change of understandings—we keep typed and handwritten notes (these are scanned and shared as jpeg or PDF files), and we audio- or videotape our research meetings. These documents allow us to review how our understandings have formed and changed over time as a function of our investigation and experiences in the field. Sixth, because all stakeholders are involved in the entire research process, continuously contributing to the sense-making effort until the final report has been prepared, member checks are a central and ongoing part of the research process.

Fields and Times: Contradictions and their Resolutions

In the following subsections, we describe how activities and their outcomes in particular fields become resources that provide opportunities and constraints in other fields and thereby lead to conflicts and contradictions in school science. We articulate our findings in terms of the following three claims. First, fields are spatially and temporally structured and intersect with one

another; at the intersections there can be contradictions because structures (including, but not restricted to time) from all intersecting fields both constrain social life and enable future actions. Second, on their trajectories through and across different fields, people, marked by their own values and accepted commonsense regarding time, find themselves in fields that support distinctive forms of culture and have temporal characteristics that differ from their own commonsense uses and preferences, giving them a sense that the organization works against them. Third, in this school, cogenerative dialoguing is emerging as a new field in which conflicts and contradictions are articulated and dealt with in new, more congenial ways.

Intersecting Fields

Rosters are created in one field but, moving in the form of printed schedules into other fields, they become structures that support agency that leads to actions and associated contradictions. We begin by articulating the activity of creating rosters and how stakeholders in other school fields perceive this process and its products. We then show how the roster is a resource that mediates science classrooms and affects student science achievement as measured by standardized examinations.

Constraints and contradictions in creating rosters

In this school, Mr. Cole—a teacher partially seconded to the main office—creates rosters centrally for the entire school. (With the decentralization of the school and administration into academies the centralization of developing student rosters is a contradiction worthy of further investigation.) The process begins toward the end of the spring and continues into the summer. The key participants in the construction of the science program are the coordinator of an academy and, if they are around, the science teachers from that academy. The coordinator and the science teachers from each academy provide details on what courses are to be taught, who is to teach them, and which students need particular courses. However, records are maintained centrally and, with reference to the complexity of the task of making rosters for over 2,000

individuals, student preferences are rarely considered when electives are scheduled. Accordingly, students receive the first hint of their courses when they return from summer vacation and are handed a computer-generated schedule.

The processes and products created in the roster office not only mediate events in other fields, but its own events are mediated by constraints that arise elsewhere as the following two examples show. First, the division of the school into academies to which teachers are associated offers less flexibility in the creation of a roster in science ("there is not much variety [in electives] for the students" [Ruben])—limited by the total number of courses teachers teach, and their specialties and interests. Accordingly, students may end up in Spanish III rather than Engineering I, of which there is only one section offered. Second, the roster production is itself mediated by information constructed in another field, with its own temporal character. In this situation, making the roster is mediated by the temporal metric of the school district, which makes its allocation of faculty for the coming school year based on its May projections of student enrollments for the coming year.

> I think one of the reasons we haven't solved it, we do not start planning early enough. For instance, we need to know what our teacher allocation will be, and the allocation is determined by the number of students in your school. So sometimes by February, things should be stable, we can start planning. But they give us our allocation based on May numbers, and May numbers could be down. From what Mr. Cole has told me, a lot of times principals want to wait to plan. (Assistant principal)

That is, the roster is an artifact that emerged from actions constrained by fields and structures elsewhere in the organization; its creation does not deal with real people but with "slots," "numbers of students," "time tables," "available teachers" and so on. The roster abstracts from the lives and social relations of the participants whose practices it structures—the roster thereby becomes an aspect of the ideological practices by means of which "objectified and universalized systems of administrations" come to *determine from the outside*, subalterns and their "actualities, always local, always particular, always individual, and inexhaustibly various" (Smith, 1990, p. 144). Concretely realized for each student and teacher in a computer printout, the roster becomes a resource that constrains and provides opportunities for action in fields throughout the school and outside of it. For example, depending on the roster, students will or will not be scheduled

into Engineering I, Bryant will or will not be required to teach the class, and lunch and an associated time for planning will be designated for a specific time interval. It thus creates a whole host of relations of simultaneity, succession, synchrony, and diachrony between reference points in different fields and at different organizational levels that never are brought face to face. The roster makes practically compatible what logically and experientially is contradictory.

From the perspective of the roster chairperson, rules governing minimal requirements and the academic histories of students are resources for action as he can schedule students into any elective to ensure that all classes have viable numbers of students and that the human (i.e., teachers) and material resources of an academy are optimally used. This perspective comes to be embodied in the roster, which becomes an objective social reality that students or teachers no longer are in a position to question: The roster is a typical object by means of which ruling relations are produced and reproduced. The roster person's actions can produce contradictions for students who find themselves in a class in which they have little interest and background, and for teachers faced with the dilemma of meeting very diverse student needs.

From the assistant principal's perspective, the roster process is an anachronism. In her view, it ought to be possible to start the process of producing a roster in February, at which point the projections for the number of students during the subsequent school year stabilize. Furthermore, the process of constructing the roster is a substantial task, so that the process should begin as early as possible. Here, two different timescales intersect and interact, leading to what is considered to be a late start for planning the next school year.

From the perspective of the SEM coordinator (Ruben), the roster creates constraints, as he has to identify science teachers qualified to teach the specific courses. Teachers, by their very nature, career-wise operate on different timescales than students. They have been educated and certified to teach in two or three subject areas. They normally expect to teach the same courses year after year and even repeatedly during the same year; in the course of doing so, teachers evolve the particular expertise that can only by acquired by teaching. However, the assignment of teachers to schools by the school district makes it also necessary for them to teach courses that

they are neither certified nor (frequently) want to teach. Accordingly, one teacher certified in mathematics was assigned to teach an engineering class because Engineering I was scheduled, she needed to teach one more class and, of the teachers free at this time, she was the most qualified to teach this course. The “necessity” for her to teach out of field was created within an administrative, bureaucratic discourse that does not take into account the standpoint and lives of those affected. From this teacher’s perspective, she would never have chosen or volunteered to teach engineering. She was assigned to teach the engineering course because there was nobody available who was better qualified to teach it. Based on the qualifications of teachers in SEM, there were too few mathematics and too many engineering courses offered. Her assignment to teach out of field arose from an intersection of the fields of the academy, roster office, school, and school district. The inappropriate assignment might have been avoided if the temporal metrics in the fields involved had been synchronized to allow for the removal of contradictions before she had to turn up to teach her engineering class. As it was, the teacher learned of her engineering assignment close to the point in time when the course would start. Then she had to scramble without the material resources, which she could not order beforehand, or which were ordered but did not arrive in time for the start of the course. In this way, science teachers in this school not only are assigned courses they are not certified to teach, but also face students who are not ready for the subject. Teachers and students at CHS deal with these constraints on a daily basis. While previous studies might have glossed over these apparently unremarkable incidents, for the actual participants and perhaps practitioners in other school settings, these are crucially important situated temporal activities and interactions that impact on the quality of learning experiences for urban youth.

From the perspective of the coordinator and science teachers in SEM, contradictions also arise because students complete the minimum requirements at different rates. For example, if students can complete their graduation requirements at the end of their junior year—that is, from the perspective of the school—students still have to complete their senior year. From their perspective, students are ready for graduation because they have completed the requisite

minimum courses (established by the school district). This, according to teachers and administrators, leads to the problem that many students in their senior year are no longer motivated in their courses, saying instead, “I don’t need to take this course; I am finished” (Ruben).

From a student perspective, the roster is an object that is received, something that is done to them rather than a record of a collective agreement. The structures truncate their agency since, typically, students are not involved in discussions about their programs of study and do not know how rosters are created, how the roster process unfolds in time, and which structures constrain the actions of Mr. Cole. At the beginning of the school year a roster is “dropped on” students, a decision, a piece of paper that shapes their academic pathways for the remainder of their high school years.

> Like they just give you classes, they don’t look at like which classes you need, and what classes you are not ready for, they just give you certain classes that [are] development for you. You like got a certain amount of time to switch it, but sometimes when you switch your class there might not be room available for you so then you be stuck in that class all of the time. (Brent)

The roster becomes a resource created in and characterized by the temporality of one field that structures the temporal unfolding of students’ high school years and their actions and choices during that time. Throughout CHS students are not involved in choosing courses to study and, even in the context of elective courses that—in their name at least—imply choice, students feel disempowered, constrained, and unmotivated. Thus, Suzie explained, “I think we should choose the electives that you are going into, like those who want to go to history, they can do a history elective, instead of taking a science that you won’t use.” As a result, students end up in classes that they have not chosen rather than those courses that serve their interests and career aspirations. They may find themselves assigned to a Physics I course, which they have already taken, and then find themselves reassigned to Chemistry II, because this is the only science course where there is room to accommodate them.

Roster mediates science teaching and learning

In this school, students are frequently assigned to classes that are inappropriate for temporal reasons. For example, students have not yet completed those courses that are or are thought to be prerequisites; the assignment is an action that creates structures that mediate future student actions. Teachers create a scope and sequence that distributes the prescribed curriculum over the semester and, in accordance with rules of the school administration, lesson plans are prepared for each period. A course therefore is sectioned into sequences of lessons in which a curriculum is enacted. However, when facing students at different places along individual trajectories, completed courses, and existing competencies, contradictions create problems in science teaching both at the short-term (lesson) and long-term planning level. Thus, two science teachers suggested:

> I have to stop the class a couple of times for a student who doesn't know how to do basic algebra. And the rest of the students are just sitting there—classroom management becomes difficult because they know how to do it and they start talking. And when you try to talk to some roster person, he is helpless, because in the whole school, there is no sequence, for what should be taught first and what should be taught second. (Physics teacher)
>
> We can't afford to have a hands-on engineering [course] and these kids aren't really rostered appropriately for this class. They should have had Physics I and Geometry first before this class. (Engineering teacher)

Stopping the class to teach what ought to be prerequisite science concepts and skills creates new contradictions between the now rearranged enacted lesson time and temporal frame of other students ready to go on but waiting for others to catch up. In fact, we observed that such stops sometimes accumulate within a science lesson to such an extent that the entire curriculum schedule for the course loses its flow. The physics teacher's comment shows that she has attempted to talk to the roster chairperson, but found Mr. Cole unable to resolve the situation other than on a case-by-case basis.

Students themselves realize that some of the problems in their science classes arise from the diversity of backgrounds brought about by the particular roster that brought them together in a specific course.

> Like we have students in [Engineering II] who never had physics. So it is like he has to teach them physics, he is teaching them physics that we already know and so it's, just confusing. (Yana)
>
> And then like she said, we got to go over and over it, we go over and over with them. And that just be wasting time. Instead of just flowing through it, as he is expecting us to. (Brent)

Here, Brent indicated that this repeated instruction of the same science content is a waste of his time. It is not surprising, therefore, when such students get bored and seek other things to do, including working on their homework or taking a nap. In both forms of action, students use time as a resource to accommodate temporal demands from another field, freeing up additional clock time to be used as a resource later in the day at home, with their friends, or for their evening jobs.

> Me and the man teaching, his class is not like challenge to many, and like I get bored very easily, so when I get bored, I find other things to do. And he thought I wanted to leave. I said I can do the work for my other—do my other work, and he said that I was in that one class and I was wasting my time not learning. I have an English III and Physics, and I actually have [for] physics like non-stop to do, and like in English III, I have a lot of things, and I am learning. (Cecil)

Frequently, student practices such as those Cecil described led to conflict with their teacher. For example, on one day that we spent at the school, Cecil and Colin were sent out of the classroom when their engineering teacher assigned busy work, which the two refused to do, instead opting to complete their homework for another course and then take a nap (we ascertained later that Colin had a fever). These students intended to make arrangements for multiple activities at the same time, monitoring their engineering class and doing homework or taking a nap. Contradiction and conflict can arise when students who are committed to people and relations, and are disposed to handle several highly contextual issues simultaneously (Allen & Boykin, 1992), interact with and find themselves in fields characterized by linear time (low-context, one thing at a time, rule- and plan-focused), such as the school, its schedules, classrooms, and teachers. We do not regard this as a deterministic process. In the present situation, the engineering teacher asked the two students to report to the coordinator, thereby increasing Ruben's load, preventing him from doing what he had planned to do, implementing support structures to improve science education.

Getting the right knowledge at the right time

The outcome of the roster process also mediates a very different activity that is coordinated by the school district office (another field). Each year, someone in the superintendent's office requires schools to administer standardized tests (e.g., the "SRA"), the results of which are resources for making decisions such as about privatizing failing schools and holding teachers accountable for the performance of their students. In the tenth-grade test, for example, there are questions from the disciplines of environmental science, chemistry, physics, and earth science, even though, at the time of testing, tenth graders may not have taken relevant high school courses in these areas.

> The tenth graders were scheduled in the roster in Engineering I, and their math skills are very weak, and they are very concerned, since they are going to be judged on SRA scores. (Bryant)

The roster therefore is a resource that mediates students' actions and performances in science in two ways. First, many students have not had the science courses where they would learn the relevant questions from the different disciplines. Students have to draw on resources constituted by what they have learned in these disciplines during their elementary school years. Second, at the point that the high-stakes tests are scheduled, students may not have attended science courses during the four preceding months, and therefore did not have classes that could have prepared them for the science part of these tests. Teachers and students are very conscious of this contradiction and efforts are made to align the science curricula with the content of the test. However, the temporal adjustments involve a longer time span than teachers and students can control, since the course of study at middle school is relevant to tests administered in high school. This contradiction is particularly important given the history of overall low scores on high stakes examinations in this school. In 2000 about 85 percent of the school's eleventh-grade students scored in the bottom quartile for math and reading on a statewide school assessment test, which is below the percentages for bottom quartile scores in similar schools in the city (70 percent in reading and 73 percent in mathematics). At this point we neither know nor have the means to establish the extent to which the currently available achievement scores are mediated,

but our interviews revealed that students, teachers, and administrators are keenly focused on the possibility of a significant cause and effect relationship.

Trajectories and Traversals

Thus far we described different fields, temporalities, and contradictions and conflicts that arise when an object from one field (roster office) enters other fields where it provides constraints and opportunities for action with respect to learning science. Considering the interactions of the different temporalities when pairs of fields interact through the passage of artifacts provides a new perspective on contradictions and conflicts. At CHS, there are many fields, each with its own characteristic temporalities, including the school entrance (where metal detectors and weapons control procedures may lead to long line ups that take hours to dissolve), hallways, administrative offices, science labs, staff rooms, coordinators' offices, and student and staff washrooms. In the course of a single day—and even more so over the months of a school year and over the careers of students and teachers—individuals traverse many of these fields. Their trajectories are marked by these traversals, and contradictions may arise from the differing temporal demands in each field. In this section, we focus on several temporal issues as seen from the perspective of an engineering teacher (Bryant), who moved from a yearlong internship in which he cotaught with a science teacher at CHS, through the summer months as he waited to see if he would be hired, and into his first two months as a regular teacher. We focus on the conflicts and contradictions arising from the different temporalities in the fields he traversed along his trajectory as a beginning teacher. That is, there were aspects of school life at an organizational level that mediated the quality of the engineering courses that Bryant was teaching and that students were getting.

From internship to first teaching

The following personal account shows that from the moment during his internship, when he was considering teaching science in this school, to the time he talked about the events at the end

of October during the following school year, Bryant had traversed many fields, each with its own characteristic temporality.

> Bryant: I didn't know whether I would be getting Engineering or how they would work in with my courses, the courses that I would end up teaching. In any case, I didn't even get confirmation, that I would be going in this position at this school until two to three weeks before the school started. So this was August 12 and we started on September 1. And in between there, we were supposed to be working full-time in the new teacher training sessions. I also had taken a summer course that I found, related to robots. So my schedule was booked full from the time I kind of got the job and the start of school. So coming in Day One, we had a few days to talk about what we were doing and we were just trying to get some materials together. Ruben was brand new at the job as the leader of the academy.
>
> So I was scrounging the Internet basically for curriculum, and I found some things that would buy me a lot of time. So I found some curriculum that seemed to integrate the math and the science and also have a design component that was hands-on. It was free, on the Internet, and all the pieces fell into place so I ran with that. That was what I built the class around; it was my initial plan. My only concerns were that I didn't have the building supplies, the supplies to build the materials in this curriculum, which were bridges. And the first week of school, we put in for a request, for materials, and we handed them in, and I was hoping that there would be a turn around on that within a couple of weeks. First I had to find out who the supply person was. I didn't know the person. I asked around and there was no obvious process that was set in place to find out who the supply person was. And this was probably a month after I started and put in that order, I started to look into that. I had found some prep time between classes that I was going to track this guy down and I finally found him, and he said that he had a huge backlog, but he was gracious enough to pull out my request and we went through it and picked some items. But this was already after a few weeks of trying to scrounge materials up on my own.

Although a decision to hire him had not been made, Bryant met with the assistant principal and the roster chairperson to talk about what he might possibly teach. From the assistant principal's perspective, the school needed someone to teach the new engineering courses that the school system required, and Bryant, in contrast to the resident teachers, had an engineering degree, was certified to teach the prerequisite courses in mathematics and physics, and had cotaught an engineering physics course during his internship. There appeared to be a fit between the school (which had courses on its roster, students who needed to meet graduation requirements, and empty time slots) and Bryant (who had relevant subject matter knowledge, areas of certification, and experiences). Nevertheless, he accepted this assignment only with some trepidation because of the leadership changes in the school and academy. Bryant articulated constraints arising from the recentness with which the courses Engineering I and

Engineering II had been created: there was not yet an established curriculum, no teachers with relevant experience, and few material resources that he could draw upon.

Additional contradictions arose. Bryant did not have time to prepare the courses thoroughly since he was being hired late; and when he was eventually hired, he had to attend a two-week training session to meet a school district requirement. He had already enrolled in and was attending a course on robotics that, while related to his teaching assignment, nevertheless constrained him in spending more time preparing a curriculum. So, when Bryant started in the school, there were just a few days left to prepare. The lack of time created a sense of urgency and he used his agency to reorganize his priorities to create time to surf the Internet in search of resources. His request for necessary materials went to the school operations officer. From his perspective, it should not have taken more than a couple of weeks to get these materials, but the materials did not come and weeks later he had to reshuffle the curriculum and his priorities, to create the time to locate the office and track his order down. A temporal organizational perspective allows us to see the contradictions arising from different fields. Bryant's order transits to the operations officer, who processes requests in the order in which they were received, following procedures grounded in the rules, and conventions of the school and school district. Unless direct representations were made to him, he established a pace of processing orders that was consistent with his history of working at the school. The pace was unrelated to classroom priorities. In contrast, the teacher and students needed materials almost every day and their absence truncated the agency of all participants in the classroom.

Delays in school operations: books and materials

During the summer, although he had not yet been offered a position, Bryant had made time to sit down with his mentor and future academy coordinator to make decisions about which books and materials to order as resources for teaching physics and the new engineering courses.

> So I ordered engineering textbooks. Supplies are different from equipment . . . the same person handles both and there is a big backlog on that. And throughout the past month and a half, some of the supplies ordered back in the spring have slowly been coming in. Some of those supplies, the

> engineering textbooks for use in one of the classes, those we haven't seen yet, they seem to have gone missing: they are still in the backlog. (Bryant)

But, when Bryant eventually found the time to check with the operations officer, he realized that this person had a backlog of orders. Other teachers were also waiting for books they had ordered in April and May, but which had not found their way into the school, and nobody knew of their whereabouts. The system for ordering books and other materials, according to the assistant principal, is cumbersome and not suited for the school: "He [operations officer] goes, 'I don't know.' Well, 'If you don't know, who does?'" The books and materials were ordered during the previous year, but nobody seems able to find them, including the school operations officer who had ordered them. That is, the timing regarding the ordering of materials, their arrival and distribution have effects in other fields, including Bryant's engineering classroom, where they impact teaching and learning processes, and even catalyzed conflict between Bryant and his students.

Problems in science teaching

There are multiple instances of how the structure of fields within the school constrains the teaching of science and engineering in the classroom. Not only Bryant, but also his academy coordinator Ruben, attributed his problems to contradictions in the organization, timescales, or organizational relations in the engineering courses ("there is Bryant by himself, and he cannot do it. He is a young teacher, and he has two engineering courses, he doesn't have the experience"). Even students recognized that there was a problem related to time and its correlate, experience.

> I guess we should be lenient, because it is like the first time that engineering is going on up here and I don't want to say they don't know what they are doing, but they don't have a lot of experience to know how an engineering class is supposed to be like. So he actually is like—basically, they don't know what they are doing. He should have a certain lesson everyday for us to do something instead of winging every day. (Suzie)

It may not surprise then that there were problems in Bryant's engineering course. Some students felt the course lacked challenge ("he goes back over stuff you have already done"), others felt it was boring ("the same every day"), yet others found it uninteresting ("it is not very interesting"). One way or another all stakeholders attributed the problems in Bryant's

engineering classroom to issues associated with time. The students suggested that he had little experience (career trajectory), a lack of temporal (having a certain lesson everyday) and material structure (lack of resources), and a lack of preparation ("he was doing [in] class, whenever, whatever he completed," "he was winging it"). The coordinator of the academy attributed the problems to lack of experience and limited access to relevant resources ("he cannot do it. He is a young teacher, and he has two engineering courses, he doesn't have the experience"). For Bryant, the structures that mediated his actions included the lack of curriculum materials due to delays, insufficient time during the school day to transition from one class to the next and gather the resources he needed to teach, inappropriately prepared students (taking engineering without previously having taken physics, mathematics), insufficient lead-time to prepare a curriculum, and, above all, his lack of experience.

> I don't blame them for the situation we're in. It's been ninety-six minutes every single day and it hasn't been the most structured or smooth or prepared class. So, I would be frustrated too if I were in their shoes. I remember when I had student teachers when I was at school and I kind of resented the fact having student teachers in my class because I knew I was getting less content less quality teaching than the veteran who has been there for thirty years. And I was expecting to get that and I got something else and it was less quality. That doesn't necessarily excuse some of their behavior that they had but I can empathize with their frustration because it is beyond this class too. (Bryant)

There is no doubt that Bryant was working hard to do his best. The academy coordinator and assistant principal were both convinced of his qualities and potential to contribute to science teaching in particular and school life in general. They were impressed by his willingness to create time as a resource to allow him to coordinate with other institutions and people (coordinator) to plan curriculum and secure the resources he needed to provide a good engineering curriculum. But temporal constraints ("things on my plate," "things have been changing") mediated, for example, the idea of providing students with a weekly plan. Furthermore, he felt "screw[ed] around" by sudden demands from the administration and had to adjust to the availability of the speakers he had invited to his class.

> We've sat down once or twice in the beginning of the year to kind of sketch out plans and he's [Ruben] given me general guideline feedback on that. He suggested giving a weekly plan to the students on paper. I decided [that] just because there were so many other things on my plate to post it. Because putting it on paper things have been changing so much. In my class and then from the

> administration down, like surprise testing this week and I have been having people coming into my class this week like guest speakers, and it has been screwing it around so I just post it on the board. (Bryant)

Crossing Times: Dealing with Contradictions and Conflict

In this school, stakeholders identified many contradictions that are central to the problems we observed with respect to teaching and learning science, and which surfaced at the interfaces of two or more fields with their characteristic temporal structures. That is, there were organizational reasons for the problems in this urban school, which cannot be attributed to low teacher morale or student motivation. This directly leads to questions concerning the resolution of contradictions: "What can members of the school community do to deal with the contradictions?" Face-to-face meetings are at the heart of organizations; this is the place and time when organizations literally and metaphorically come together, allocate a common time to create and maintain the practical activity of organization (Boden, 1994). Face-to-face meetings can allow for people from different fields to identify and resolve contradictions and in so doing create collective responsibility and an associated division of labor to resolve problems. In this section, we articulate two ways in which conflicts and contradictions created by the intersection of fields are dealt with at CHS—the resolution of roster conflicts through the coordinator's actions and the resolution of conflicts and contradictions between students and teachers through *cogenerative dialoguing*. In both situations, time is actively manipulated, produced to become a resource for resolving extant conflicts and contradictions.

Resolving roster conflicts

At CHS students can attempt to get roster problems dealt with by filling out a problem slip during the first week of classes, which they hand to the academy coordinator. From Ruben's perspective, this creates havoc, for they receive many slips at the same time: "I got a hundred problem slips. So then I have to take a hundred problem slips. The kids are already going to classes; they are leaving classes, to ask me fix their rosters." Although there are problems with their rosters, all students have to attend classes. That is, even though a student wants to transfer

out of some science class (for example, because they have already taken it in the past), they have to attend until their problem is resolved. This creates further problems if they eventually get transferred since they may miss several weeks (depending on where they are in the queues of the coordinator and roster chairperson) of instruction in another science class. When they finally are re-assigned they are already behind, out of step with the curriculum as planned by the teacher.

It turns out that it is difficult to enroll students in a course offered in another academy, which is another field, with its own contingencies and constraints arising from its problems with slips, schedules, and students. Ruben suggested, “The school is very provincial in terms of floors, so to get someone from your floor to someone else’s floor is just a groveling thing [though] they have enough room to put a kid.” In trying to get a student into a course offered in another academy Ruben found himself at odds with its coordinator: “I have stepped on her toes a little bit by trying to get my kids classes. So I just looked in the system, and I saw these are geometry classes that had space downstairs, and I said, ‘Wait’ and I put them in that class.” Ruben would like to be able to make a plan for a school year starting in September, then take that plan to the guidance and roster chairpersons to establish the rosters no later than April. This, however, is incompatible with the temporality in another field, the school district office, which provides the allocation of teachers only in May, a schedule that mediates the process of hiring. However, this does not deter Ruben who seeks to avoid the position in which he found himself at the end of October. He hopes to have all potential roster-related problems resolved by the time the new term starts in January.

Moving students between academies appeals as an obvious solution to a roster problem and for teachers having to teach out of their fields of certification. Students could look at the schedules across the entire school and if space permits, select a course that meets their needs and interests. Similarly, teachers might be assigned to teach in more than one academy, thereby allowing them to teach in their certification areas. Such an arrangement might increase the quality of science education throughout the school. However, structures created by a previous principal make both courses of action problematic. Thus, academies were created to address

pervasive problems of inner-city life, including a desire to provide personalized learning environments and safety from rampant gang-related violence in hallways and bathrooms. By creating small schools (now called academies) located in different parts of the school, each with its own schedule out of synchrony with those of other small schools, administrators intended to decrease the time that the gangs came to cross each others' paths. This organizational framework enabled school police and non-teaching assistants to maintain safe corridors, keep students in classrooms, and restrict opportunities for gangs to use school spaces as staging arenas.

Cogenerative dialoguing

In this school, *cogenerative dialoguing* is the name for a form of interaction that explicitly seeks to support the construction of understanding and solutions to problems that have arisen from contradictions that stakeholders have experienced, albeit from different positions in this school organization. The practice has arisen in this school as a result of and in interaction with our ongoing institutional ethnography when members of the organization experienced them as a means for taking control over and changing their conditions (Tobin & Roth, 2006). Fundamentally, cogenerative dialogues bring together different stakeholders in some issue—in our context, this included (some or all of) students, new (intern) teachers, regular teachers, department heads, principals, university supervisors, researchers—come together to make sense and to design policies and strategies of actions to be implemented collectively. In contrast to other communicative approaches (e.g., "conflict resolution," "peer mediation"), *dialoguing* denotes the form of relation required in liberating learning, when subjects "meet to *name* the world in order to transform it" (Freire, 1972, p. 136). *Cogenerative* denotes the fact that nobody (especially researchers or individuals in power-wielding institutional positions) has a hold on knowledge, theory, and understanding.

At CHS, cogenerative dialogues have become fields with the potential for identifying and resolving contradictions, catalyzing changes, and creating collective responsibility for maintaining them. Cogenerative dialogues have worked so well that the current assistant

principal has begun to encourage teachers across the entire school to use them for resolving contradictions, especially conflict between students and their teachers. In SEM, cogenerative dialogues are an important means for resolving issues of conflict that interfere with teaching. They constitute a form of meeting time, where teachers and students get together in order to deal with contradictions and conflict. Sometimes Ruben, the coordinator of SEM, participates in a cogenerative dialogue to mediate power-over issues. The following example derives from a cogenerative dialogue involving a selection of five students from Bryant's Engineering II class in which participants discussed conflicts arising from their shared experiences.

Bryant learned to do cogenerative dialoguing during his teacher certification program, and continues to enact the practice with his students during his first teaching job. However, several previous cogenerative dialogues involving Bryant and the students did not seem to have brought about the desired changes on the part of the students:

> I think Mister Bryant knows what is going on and everything and how to do the stuff—And so we had an open discussion in class about how to change to make the [Engineering] class run smoother and make the class like get us more and stuff. We talk about it with him. But it isn't like nothing he really can do. (Suzie)

Here, Suzie came to the conclusion that there is nothing Bryant could really do to better the situation, particularly in view of the fact that some of the problems, as described in the previous section, had their origin in contradictions of temporality. First, Bryant lacked experience, and second, there could be no short-term resolution to the contradictions arising from being hired late, essential resources not arriving on time, and preparing the curriculum on-the-fly.

Because previous cogenerative dialogues did not result in agreed-upon changes, the coordinator of the academy was informed and he created the time to participate. The following is an excerpt from a cogenerative dialogue in which he participated with student representatives, Bryant, and one of the researchers.

Kevin: He would explain it. It be the right stuff. It's just the way he would explain it.
Ruben: If you were going to give us a recipe to fix the way he explains, what would he do differently?
Kevin: Make it easier, simpler.
Allan: Right.

Brent: Explain it clearly
Ruben: Make it simpler and explain it more clearly.
Bryan: I feel I'm going to fail.
Allan: I know. ((Others join in chorus.))
Ruben: Excuse me! You guys are not going to fail all right. That's why we're here. So let's figure that out. So explain the work in simpler words and define all the words.
Gina: Well we'll have our hand up like this waving it around saying, "Mister. Bryant, Mister Bryant, you walking over there, where you going?"
Ruben: ((Laughs)) Walking over there, where you going? Okay, so?
Gina: No, it's true. I'm not lying!
Ruben: (to Bryant) That's something for us. Where the science teachers and the math teachers need to talk about our different teaching styles and we need to figure that out. That's a very good comment, okay? Because we do teach things differently in different classes and that does lead to confusion. Sheila? Is there anything you want to say?
Sheila: All I want to say I can see how changing strategy is going to make it easier but then again you can't hold our hand we're suppose to be in high school and they won't be doing that over at college, we're going to have to sit there and listen. He explains things. I can understand what he's saying sometimes. Sometimes it is a little bit confusing, but it is like I don't want him walking us through everything.

In this episode, students articulated what they perceived to be the problem in their Engineering I class. Ruben assisted students in bringing forth what he perceives to be the salient issues by summarizing and explaining ("Make it simpler and explain it more clearly," "Explain the work in simpler words and define all the words"). Using simple words and defining all the words were aspects of Ruben's teaching practices that had allowed him to become accepted by the students. This articulation of his teaching practice, and the absence of it in Bryant's teaching the engineering course made salient differences in teaching styles, which Ruben flagged for discussion with other teachers in SEM.

In the final part of the transcript, Sheila articulated another contradiction arising from differences of timescale, that is, for those students on particular career trajectories and who want to attend college. Thus, while for these students the course might become easier in the short term when the teaching strategies are changed ("to hold students' hands"), they might actually find it more difficult to cope with the demands when they arrive at the college level.

At the time we conducted this research, the participants had only recently started to use cogenerative dialoguing to address problems in the fields of the academy and school. They did not yet arrive at solutions, in part because the problems arose from systemic contradictions,

which need to be addressed by involving those occupying other fields, including the principals, Mr. Cole, and the coordinators of the different academies. Nevertheless, these cogenerative dialogues had positive outcomes in the sense that students and teachers were able to articulate systemic contradictions rather than viewing problems and conflicts in terms of their immediate experience (i.e., "he said, I said" or "he did I did"). In fact, cogenerative dialoguing has brought about positive changes so that there are attempts to institute it as a means to mediate conflict arising between students and teachers on a broader scale within the academy and the school at large. Thus, when problems arise between students and teachers who do not yet practice cogenerative dialoguing, Ruben makes arrangements to foster the practice, which is a powerful way of dealing with cross-field structural contradictions. For example, to mediate in the previously identified conflict between Cecil and Colin on the one hand and Bryant on the other, Ruben proposed:

> Can you just have a seat, and then, when this is over, do you mind going back with me to him and just hash it out? And then we can say what you want to say to him, and we can do it in an adult fashion okay? And when we are finished, you and me are going back to Mister Bryant and chatting a little bit. You can't sleep in there [engineering course] but you can sleep in here . . . we straighten it out, we'll have a talk, because he may be able to if the class is not more—you want the class to be harder.

Central to the success of cogenerative dialoguing is an initial collective commitment to change priorities, thereby providing temporal spaces in which participants from the different niches within an organization can dialogue with the intention of negotiating shared resolutions to identified problems and collective responsibilities for enacting agreed upon changes in roles. In so doing there needs to be an explicit recognition that participants occupy fields that are inscribed with different temporal metrics that must be considered when agreed to solutions are enacted. Differences in these temporal metrics can shape expectations about whether or not all participants are meeting their commitments to shared agreements and responsibilities for changes in goals and roles. As we have shown here, cogenerative dialogues constitute an important forum for enacting collective leadership (Ritchie, Tobin, & Roth, 2007), providing participants with opportunities for influencing practices and negotiating structures in schools like CHS.

Discussion

In this article, we describe a school as an organization that is partly structured by time metrics that are dialectically interconnected with the agency of all participants. The dialectical relationship ensures that time metrics do not merely impinge on and structure action but also are an outcome of action. We show how events outside science and engineering classrooms mediate the teaching and learning that goes on within them. The key to understanding schools from an organizational perspective is not to look at a planning chart that relates the different positions in a school and school district; it is also insufficient to merely look at culture and the practices of different people (e.g., teachers) to understand why students do not learn science and do poorly on high-stakes examinations or why teachers teach science in the way they do. Rather, in a dialectical fashion we have to examine a number of seeming dichotomies such as organization and individual or whole school and academy. Just as it is seen as a limitation to ignore time as a key construct in a study of education so too is it clear that many of the existing problems at CHS reside in a tendency to regard solutions to problems in terms of either/or (i.e., as dichotomies) rather than in terms of both/and approaches (i.e., dialectics). In an either/or approach, the reigning ideology requires one solution; in a both/and approach, two or more contradictory solutions each with a limited and contingent context of application (i.e., field) may be adopted. An obstacle to the adoption of both/and approaches to school organization is that temporal alignments, which frequently require negotiation of changes to priorities, are often seen as infeasible and not the focus for negotiation and change. “School days” and “holidays,” “exam schedules” and “rosters,” “deadlines” and “calendars,” “reporting periods,” “announcements on the PA by the principal,” “pre-lab activities” and “after-school activities,” and “being on time” and “being late” are all about temporal orientation, timing, pace, cycles, and rhythms. Taking a temporal lens to examine organizational activities provides an important perspective for describing and explaining organized, collective activity, whether it is in an industrial company, a school system, or, on a smaller scale, in a school and its classrooms.

Time, Organization, and Experienced Curriculum

Contradictions and conflict continuously emerged in this school because of misalignments between the temporally linear organization of the school day and the way students and teachers experience and organize their activities. The temporal constraints placed on Mr. Cole led him to consider actual students and their preferences rarely, with the effect that the students cannot complete a program of study of their own choosing, but instead follow one that has been imposed upon them. The very organizational discourse that gives Cole power over students and teachers and rationalizes his position is blind to the actual experiences of the people that it rules.

The students' lives in their entirety are mediated by the timescale in the roster office. In fact, student success and failure in specific science courses and in the science and engineering program that the academy offers more generally are mediated by timescales over which students have no control. This is a concrete instance of the violence that participants experienced as coming from the contradictions in the temporality of the school organization. At the same time, the school cannot plan the hiring of teachers, for the number of staff on its roster depends on the number of students enrolled in the school and the associated allocation of new teachers authorized by the school district. This, as we showed, mediates teacher readiness and preparation for successfully teaching their assigned courses. Other contradictions are observed at CHS as students traverse through fields, with implications for events in specific classrooms. For example, students who arrive late for school (because they were late getting up, met friends coming to school, were caught in the traffic) are required to wait before entering the school building, get processed, and then serve a detention after school for their late arrival; at times, they were not even admitted when they were as little as five minutes late. Hence, students might come late to their class, or miss it entirely, preferring to skip school rather than serve a detention for coming late. Accordingly, students do not participate in the activities of the missed day, with the consequence that they do not have the prerequisites for content and activities (e.g., lab, test) scheduled for subsequent days. From a school and teacher perspective, students also "take their time" and "come late" to science classes, thereby mediating the enacted curriculum and the amount of science that can be taught and learned.

Taking time and therefore coming late can be seen as a conflict arising from the different cultural values related to time, that is, arising from the sense of time typical of African American students and the linear conception and practice of organizing the school day, semester, and school year. From the perspectives of administrators and teachers, the policy of refusing students to enter school or classroom is justified on the basis of teaching students to be on time. From a cultural perspective, this is a form of experience that others denoted by the terms *structural violence* and *hegemony*, where linear time conceptions and experiences are forced upon a conception and experience of time characteristic of many African American youth (Allen & Boykin, 1992). The practice of slotting students into courses and time blocks makes it easier for the roster chairperson to produce a school-wide roster but it also reproduces inequalities along the boundaries of culture and socioeconomic status—it is inconceivable that the students and parents in suburban schools would accept what is experienced as an arbitrary assignment of courses, course sequences, schedules, and so on.

Making *Time to Remove Contradictions and Mediate Conflicts*

In this study, we showed how internal contradictions arise from temporal differences between the fields that make an organization. While some conflicts may be mediated at the classroom level, many contradictions could not be resolved at that level because of structures emanating from other fields. Such problems require formal analysis and a more encompassing approach, bringing stakeholders from other fields to deal with problems by identifying structural contradictions. Cogenerative dialoguing is a practice used by individuals new in the school administration (assistant principal, SEM coordinator) that has the potential to be an important means for removing and changing the emerging conflicts and contradictions. During face-to-face meetings, different stakeholders and peers can get themselves “onto the same page,” align their visions and actions, and negotiate collective goals and roles and responsibilities for accomplishing them. Informal and formal, brief and extended, and unplanned and planned meetings are at the heart of negotiating and coordinating the different fields and temporal zones.

Agendas, actors, times and places vary, but meetings are the proper organizational activity for management, locating and legitimating both individual and institutional roles. But the alignment of different temporal zones, necessary to bring about a common meeting, is itself fraught with difficulties. Therefore, time is a reflexive issue, because an alignment of time is required to bring different temporalities in the organization into alignment. It is difficult to schedule meetings, but meetings are the place where conflicts arising from temporal misalignment can be dealt with.

Problems remain even though there have been ongoing efforts to remove contradictions by changing the organizational framework of the school. However, resolving the contradictions identified in this paper will require a different focus of attention. For example, we might ask, "Why aren't students involved in discussions about the roster, their interests and career goals?" To involve them in discussions with relevant stakeholders requires the synchronization of time across a number of fields; it requires actively using and producing time as a resource. This is not impossible and is accomplished in most suburban schools where it would be unthinkable for others to determine a program of study for any student without his or her substantive and ongoing input. Why then are urban students subjected to this form of oppression? Well-intentioned delegates, doing things to improve education on behalf of students whom they do not involve in creating the solutions, catalyze many of the problems we articulated. The lack of collective input at the stage of creating a new academy, for example, resulted in students who were neither equipped nor interested in being in an academy that was going to focus on science, engineering and mathematics. The students had not participated in the collective production of this structure and found themselves assigned to academies. But this is oppressive, even though it is not intentionally so. The students were moved into a field to be participants without being involved in the decision; so it was with rosters. The new practice of cogenerative dialoguing appeals as a potential solution to many of the remaining contradictions. However, as we have shown here, enacting cogenerative dialogues involves temporal alignments that necessitate a change in the institutional priorities. It is certain that synchronizing the schedules of individuals

and groups to identify and resolve problems takes time, which therefore has to be made specifically for this purpose.

Conclusion

This research has relevance to education at a time when national, state, and school district policies have aligned to emphasize the responsibilities and associated accountabilities of individuals for achievement. Policies such as these create contradictions for teachers and students whose roles and responsibilities in the classroom are responsive to structures that are shaped by practices and associated schema that continuously unfold as interactions between participants occur. The agency of all participants in a classroom is interconnected with a dynamic structure that demands immediate action and artifacts and schema from other fields that reflect the practices of participants in fields within and outside of the school and are inscribed by their ideologies and constituent beliefs, values and interests. Holding teachers accountable for the achievement of students creates contradictions for all participants and can lead to students becoming alienated. Our study showed that the conditions leading to underachievement frequently do not arise within and from the lived world of students and teachers, but from the organization and articulation of academy, school, and school board levels. Improving education therefore cannot be solely a question of including this or that curriculum topic, changing teacher preparation, instituting accountability procedures, and so forth; improving education requires us to understand how teaching and learning are mediated by determinations that are beyond the control of teachers and their students because they arise from the organizational relations between classrooms, academies, schools, and school boards. We need to problematize the familiar to address significant temporal issues in the implementation of effective school programs. By questioning the status quo in school organizational structures and for participants to engage in cogenerative dialogues to resolve contradictions and conflict, it might be possible to move beyond what insiders in a situation consider to be common knowledge.

Recent reports have shown that the turnover of teachers (Ingersoll, 2003) and especially the attrition of new teachers is an epidemic that urban school districts seem impotent to resolve

successfully (Neild, Useem, Travers, & Lesnick 2003). This study reveals that Bryant, a beginning teacher, has more than sufficient incentive to move to another (suburban) school where he would get a substantially higher salary, or to leave teaching entirely. Yet, he prefers to stay at CHS to teach science to students just like those he is presently teaching. Our analyses suggest that temporal issues underlie many of the problems Bryant, his colleagues and their students have to overcome. Yet the temporal characteristics of the structures that truncate the agency of teachers and students do not reveal their temporal nature and efforts to improve the quality of science education, though well intentioned, are often misdirected. Educators cannot afford to ignore studies of organizational criteria, rationalizing their actions with the comment that the research might have been done in any curriculum area. This study has major implications for researchers, policy makers and practitioners within schools and must be considered alongside of other research and policy to ensure that temporal issues are on the agenda for research, policy and curriculum enactment. We cannot afford to dismiss temporal issues as common sense, leaving their resolution to students, teachers and school level administrators and personnel. Further study of the temporal characteristics of organization is a fertile ground for research in education.

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